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CON-1
Rij is found by a shift direction operation section, and the design pattern data in the direction in which the total of the pixels is minimum is selected from the difference data by a selection section, the difference between the central pixels S_{ij} , Q_{ij} of the selected design pattern data and the central pixels S_{ij} , Q_{ij} of the windows of the real pattern data is found by a difference operation section, and the difference and a threshold are compared in a defect judgment section, and thereby the pattern inspection of the object is carried out.

IN THE DRAWINGS

Approval of the attached proposed drawing changes to Figures 5 and 12 is respectfully requested.

REMARKS

Favorable consideration of this application is respectfully requested.

Proposed drawings changes are submitted with the present response to address the objections noted in paragraphs 1 and 2 of the outstanding Office Action. More specifically, in the proposed drawings changes Figure 5 is proposed to be amended to recite the phrase "Design Pattern Memory Rig". Further, Figure 12 is proposed to be amended to include the reference numerals 228 and 233.

The specification and abstract are amended by the present response to correct for minor informalities, and to specifically address the objections noted in paragraphs 3 and 4 of the outstanding Office Action. With respect to the objection to page 36 of not defining the term " $T(x, y)$ ", it is noted that on page 36 that term is defined in relation to the standard image $R(x, y)$ and the inspection image $P(x, y)$, and thus the term $T(x, y)$ is believed to be properly defined mathematically.

The changes made to the drawings, abstract, and specification are believed to be self-evident from the original disclosure, and thus are not deemed to raise any issues of new matter.

Claims 1-4, 6-11, 13-18, and 20-31 are pending in this application. Claims 5, 12, and 19 are canceled and claims 21-31 are added by the present response. Claims 1-4 and 8-11 were rejected under 35 U.S.C. § 102(b) as anticipated by U.S. patent 4,641,350 to Bunn. Claims 15-18 were rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. patent 6,175,953 to Scepanovic et al. (herein "Scepanovic") and Bunn. Claims 5 and 12 were rejected under 35 U.S.C. § 103(a) as unpatentable over Bunn in view of IBM Technical Disclosure Bulletin NN9106470, "Improving Apparent Bandwidth of Refresh Displays" (herein "IBM TDB"). Claims 7 and 14 were rejected under 35 U.S.C. § 103(a) as unpatentable over Bunn in view of U.S. patent 4,547,800 to Masaki. Claim 19 was rejected under 35 U.S.C. § 103(a) as unpatentable over Bunn in view of Scepanovic as applied to claim 15, and further in view of the IBM TDB. Claims 6, 13, and 20 are objected to as dependent upon a rejected base claim, but are noted as allowable if rewritten in independent form to include all of the limitations of their base claim and any intervening claims.

Initially, applicants gratefully acknowledge the early indication of the allowable subject matter in claims 6, 13, and 20.

Addressing the above-noted art rejections, those rejections are traversed by the present response.

It is initially noted that each of independent claims 1, 8, and 15 is amended by the present response to clarify features recited therein. Specifically, independent claim 1 is amended to incorporate the limitations of canceled dependent claim 5, and to specifically further recite "wherein a shift width of the shifted design pattern windows is within one pixel". Independent claims 8 and 15 are similarly amended to incorporate the limitations of

canceled dependent claims 12 and 19, respectively. Such subject matter is believed to distinguish over the applied art.

Original claims 5, 12, and 19 were rejected over Bunn in view of the IBM TDB, and further in view of Scepanovic with respect to claim 19. However, those teachings are not believed to meet the limitations recited in amended independent Claims 1, 8, and 15.

The rejection of previously pending claims 5, 12, and 19 relied upon the IBM TDB disclosing a shift width of shifted design pattern windows within one pixel on pages 1 and 2 and also in Figure 3.² However, it is respectfully submitted that the IBM TDB teachings differ from the claimed features.

The IBM TDB only discloses a method of improving a picture quality, in which a first frame slightly shifted with respect to a second frame antecedent to the first frame is displayed once every T time units. A shift width between the first and second frames can be within one original grid.

However, the shifting method disclosed by the IBM TDB intends to improve a picture quality, for example to reduce a Moire pattern compared to a method of displaying frames at the same position. However, in contrast to the claimed invention, the shifting method disclosed by the IBM TDB does not intend to improve an inspection precision with respect to an inspection object.

In other words, the claimed shifting method and apparatus are used for comparing a shifted non-defective pattern data window with an inspection pattern data window, which is in contrast to the IBM TDB's shifting method used for improving a picture quality.

In such ways, the technical field of the shifting disclosed by the IBM TDB differs from that of the above-noted claims, and in such ways a concept of the shifting method disclosed by the IBM TDB is not properly applied or applicable to the above-noted claims.

² Office Action of January 15, 2003, page 6, lines 4-6 of prenumbered paragraph 9.

With the structure recited in claims 1, 8, and 15, since a shift width is within one pixel, it is possible to detect defects lower than the pixel resolving power in the inspection object, see for example the present specification at page 24, line 17, to page 40, line 13.

In such ways, each of claims 1, 8, and 15, and the claims dependent therefrom, are believed to distinguish over the teachings in the applied art.

The present response also sets forth new claims 21-31 for examination which are also believed to recite allowable subject matter.

One feature of the new claims recites in that, for example as recited in new claim 21, a shift window of a non-defective pattern window is within one pixel, and the shifted non-defective pattern window is used for a comparison with the inspection pattern data window to inspect an inspection object. The other new independent claims recite a similar feature. Such new features are believed to clearly distinguish over the applied art. Thus, new claims 21-31 are also believed to be allowable.

In summary, the present response amends the drawings, abstract, and specification to address the objections thereto. Further, amended independent claims 1, 8, and 15, and the claims dependent therefrom, are believed to distinguish over the applied art. New claims 21-31 are also believed to recite allowable subject matter.

As no other issues are pending in this application, it is respectfully submitted that the present application is now in condition for allowance, and it is hereby respectfully requested that this case be passed to issue.

Respectfully submitted,

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IN THE SPECIFICATION

Please insert the following heading at page 1, between lines 9 and 10:

FIELD OF THE INVENTION

Please insert the following heading at page 1, between lines 26 and 27:

DISCUSSION OF THE BACKGROUND

Please replace the paragraph at page 2, lines 12-17, as follows:

A mask having an auxiliary pattern is inspected. More specifically, the data representing the real pattern obtained by photographing the auxiliary pattern is compared with the data representing the design pattern, thereby to determine whether the [patter] pattern has defects or not.

Please replace the paragraph at page 2, line 18, to page 3, line 1, as follows:

Circuit patterns are made smaller and smaller as described above, and the resolution of the real pattern obtained by photographing of the circuit pattern is approaching the width of each element of the real pattern. In other words, the pattern precision is increasing. Thus, in a method in which differential is effected to detect the direction of a corner or an edge and real pattern data and design pattern data are compared, the position shift may occur between real pattern data and the design data. This inevitably [lower] lowers the accuracy of pattern inspection.

Please replace the paragraph at page 3, lines 3-6, as follows:

Accordingly, the object of the present invention is to provide a method and apparatus [for] which can inspect a pattern with high accuracy without a position shift between real pattern data and design data.

Please replace the paragraph at page 14, line 21, to page 15, line 1, as follows:

To the real pattern memory 4 and design pattern memory 6, [a] window extraction sections 7, 8 are connected respectively. To one window extraction section 7, a difference operation section 11 is connected via delay sections 9 and 10. To the other window extraction section 8, the difference operation section 11 is connected via a shift direction operation section 12 and a selection section 13.

Please replace the paragraph at page 19, lines 5-20, as follows:

In the step #3, the shift direction operation section 12 receives the design pattern data R_{ij} of the 7×7 window extracted by the window extraction section 8. The section 12 prepares design pattern data Q_{ij} of the total of 9 windows [form] from the design pattern data R_{ij} . Of these nine windows, the first is a basic 5×5 window with a noticed pixel located in the center. The other eight windows have been obtained by shifting the design pattern data of the basic window by $\frac{1}{2}$ pixel, in eight directions of 0° , 45° , 90° , 135° , 180° , 225° , 270° , 315° , respectively. The shift direction operation section 12 shifts the window by $\frac{1}{2}$ pixel from the sum ratio of adjacent pixels when the window of the design pattern data is shifted in the eight directions of 0° , 45° , 90° , 135° , 180° , 225° , 270° , 315° .

Please replace the paragraph at page 22, line 27, to page 23, line 12, as follows:

In the step #8, the repetitive execution section 15 determines whether the pattern inspection for all pixels of the real pattern data S_{ij} has been completed or not. If the section 15 determines that the inspection has not been completed, [if] the flow proceeds to the step #9 and shifts a noticed pixel K by one pixel as shown in FIG. 7. [The] Then, the flow returns to the step #1, whereby the steps of inspecting the pattern of the object 2 are sequentially effected by the shift direction operation means 12, selection section 13, difference operation section 11 and defect judgement section 14, for all the pixels of the real pattern data.

Please replace the paragraph at page 25, line 26, to page 26, line 4, as follows:

[An] And then, the mask pattern is formed by irradiating the Cr light shielding film formed on the substrate with an electron beam (S2). Next, the inspection of the mask pattern is performed in accordance with above described inspection process (S3), and it is determined whether or not the mask pattern has a defect (S4).

Please replace the paragraph at page 26, lines 5-10, as follows:

In step 4, if it is determined that the mask pattern has a defect, the defect is recovered (S5) and the process of manufacturing the mask pattern is terminated (S6). Furthermore, in step 4, if it is determined that the mask pattern has [not] no defect, the process is terminated (S6).

Please replace the paragraph at page 28, lines 20-26, as follows:

The window extraction section 7 has the function of extracting the inspection pattern data of a window of 5 x 5 pixels (5 x 5 window, hereinafter) with a noticed pixel in the center, for example, and supplying the data to the delay section 9 in order to carry out a local inspection of the inspection pattern data stored in the inspection pattern memory [4] 131.

Please replace the paragraph at page 29, line 16, to page 30, line 1, as follows:

The shift direction operation section 12 has the function of receiving the non-defective pattern data of the 7 x 7 window extracted by the window extraction section 8. Based on the non-defective pattern data, the section 12 prepares non-defective pattern data of a nine 5 x 5 window. More precisely, it prepares a basic pattern data of a noticed pixel located in the center and pattern data of eight 5 x 5 windows, obtained by shifting the basic non-defective pattern data in eight directions of 0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°, for example, by a 1/2 pixel. The section 12 then [find] finds the difference data between the non-defective pattern data and the inspection pattern data.

Please replace the paragraph at page 30, line 18, to page 31, line 1, as follows:

The difference operation section 11 finds the maximum value and the minimum value in the position of a [notice] noticed pixel when the standard image is shifted from the noticed pixel of the standard image and the surrounding pixels thereof. If the difference between the noticed pixel of the inspection image and the noticed pixel of the standard image is in the range between the maximum value found and the minimum value found, the difference operation section 11 determines that the difference is a noise, and does not output the difference.

Please replace the paragraph at page 31, lines 15-19, as follows:

The image device 1 uses a non-defective semiconductor wafer as [a] an object, and inputs the image of the object such as a circuit pattern formed in the semiconductor wafer and outputs the image signal thereof.

Please replace the paragraph at page 31, line 24, to page 32, line 1, as follows:

Then, a general semiconductor chip, [a] an object 2, is inspected. That is, the image device 1 inputs the image of a circuit pattern formed in the object 2 and so on, and outputs the image signal thereof. The image signal output by the image device 1 is converted by the A/D converter 3, to digital inspection pattern data. The inspection pattern data is stored into the inspection pattern memory 131.

Please replace the paragraph at page 32, lines 15-25, as follows:

Then, the image scanned by the image device 1 is converted by the A/D converter 3, to non-defective pattern data. The non-defective pattern data is input to the non-defective pattern memory 132. Thus, the image signal is stored in the non-defective pattern memory [4] 132 as non-defective pattern data. The image of the object 2 is scanned by the image device 1, and is converted by the A/D converter 3, to inspection image data. The inspection image data is input to the inspection pattern memory 131 as an inspection image (S1).

Please replace the paragraph at page 35, lines 2-7, as follows:

If the difference is greater than the maximum value, [output] the value obtained by the maximum value [being] subtracted from the difference (S14) is output. And if the difference is smaller than the maximum value, it is determined whether the difference is smaller [or] than the minimum value or not (S15).

Please replace the paragraph at page 35, lines 8-12, as follows:

If the difference is smaller than the minimum value, [output] the value obtained by the minimum value [being] subtracted from the difference (S16) is output. And if the difference

is smaller than the minimum value, [output the] value "0" is output (S17).

Please replace the paragraph at page 38, lines 3-8, as follows:

An inspection table 223 on which [a] an object 222 is put consists of an XY stage 224 and a θ stage 225 on the XY stage 224. With the inspection table 223, a loader 226 which carries a semiconductor wafer, which is the object 222, and an unloader 227 which delivers a semiconductor wafer are connected.

Please replace the paragraph at page 38, line 24, to page 39, line 6, as follows:

The device so constituted operates as follows: first, a semiconductor wafer, which is [a] an object 222, is taken out of a magazine not shown and is carried by the loader 226, and put on the inspection table 223. As to the position shift of the semiconductor wafer on the inspection table 223, the rotation shift is corrected by the θ stage 225 and the center shift is corrected by the XY stage 224. And the fine alignment of the lens system is corrected by auto focus if necessary.

Please replace the paragraph at page 40, lines 5-11, as follows:

Although in the above embodiment [the according to] the present invention is used in the semiconductor chip inspection device, the present invention can be applied not only in the semiconductor chip inspection device but also in a mask or reticle inspection device, or an inspection device of a print base or a liquid crystal base and so on.

IN THE CLAIMS

1. (Amended) A pattern inspection method comprising:

acquiring difference data by subtracting a real pattern window having real pattern data corresponding to predetermined pixels of the real pattern data obtained by imaging an inspection object from a design pattern window corresponding to the real pattern window and shift design pattern windows which are obtained by shifting the design pattern windows in a plurality of directions, respectively, wherein a shift width of the shifted design pattern windows is within one pixel:

selecting one window from the design pattern window and shift design pattern windows such that the selected one window has a minimum difference data; and

performing a pattern inspection of the inspection object based on a difference value between the selected one window and the real pattern window.

5. (Canceled).

8. (Amended) A pattern inspection device comprising:

means for acquiring difference data by subtracting a real pattern window having real pattern data corresponding to predetermined pixels of the real pattern data obtained by imaging an inspection object from a design pattern window corresponding to the real pattern window and shift design pattern windows which are obtained by shifting the design pattern windows in a plurality of directions, respectively;

means for selecting one window from the design pattern window and shift design pattern windows such that the selected one window has a minimum difference data, wherein a shift width of the shifted design pattern windows is within one pixel; and

means for performing a pattern inspection of the inspection object based on a difference value between the selected one window and the real pattern window.

12. (Canceled).

15. (Amended) A method of manufacturing a mask comprising:

preparing a substrate with a light shielding film on which a mask pattern is formed;

and

inspecting the substrate with the light shielding film on which a mask pattern is formed,

wherein the inspecting step comprises:

acquiring difference data by subtracting a real pattern window having real pattern data corresponding to predetermined pixels of the real pattern data obtained by imaging the mask pattern from a design pattern window corresponding to the real pattern window and shift design pattern windows which are obtained by shifting the design pattern windows in a plurality of directions, respectively, wherein a shift width of the shifted design pattern windows is within one pixel;

selecting one window from the design pattern window and shift design pattern windows such that the selected one window has a minimum difference data; and

performing a pattern inspection of the mask pattern based on a difference value between the selected one window and the real pattern window.

19. (Canceled).

21-31. (New).

IN THE ABSTRACT

Please amend the Abstract on page 51 to read as follows:

ABSTRACT OF THE DISCLOSURE

The difference data between the real pattern data S_{ij} , and a 5 x 5 window with a noticed pixel in the center and the design pattern data R_{ij} obtained by the design pattern data of the window being shifted in a plurality of directions with respect to the design pattern data [Rig] \underline{R}_{ij} is found by a shift direction operation section, and the design pattern data in the direction in which the total of the pixels is minimum is selected from the difference data by a selection section, the difference between the central pixels S_{ij} , Q_{ij} of the selected design pattern data and the central pixels S_{ij} , Q_{ij} of the windows of the real pattern data is found by a difference operation section, and the difference and a threshold are compared in a defect judgment section, and thereby the pattern inspection of the object is carried out.

IN THE DRAWINGS

Approval of the attached proposed drawing changes to Figures 5 and 12 is respectfully requested.